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SPRAYING PROGRAM FOR ORCHARDS WITH COMBINATIONS RECOMMENDED

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A regular spraying program is now considered a necessity by every successful orchardist, the expense of which, treated as insurance, can no more be escaped than the outlay for cultivation, manures or pruning. The beginner in orcharding and the average farmer with a small orchard is quite dependent on simple, yet effective programs for treatment. He needs to know what combination of sprays can best be made, and exactly when these sprays can best be applied to obtain the maximum of results with a minimum outlay of effort and money. Therefore, we have prepared the subsequent programs for spraying orchards of apple, pear, plum and peach, basing them upon many years of observation and experimental testing. In the control of plant enemies, including both insect pests and fungus parasites, there are essential points in practice which may not be evaded or neglected, namely: To spray at the correct time, to use the proper form and strength of spray and to make a thorough covering of the parts sprayed.

TIMELINESS OF APPLICATION

Special emphasis is placed upon the timeliness of any spray to produce results. The known life history development of the parasite to be controlled determines the time and, therefore, the best practice in securing control. Thus, in treatment for San Jose scale, successful control depends upon the use of strong sprays when the tree is practically dormant. These principles apply to all fruit trees and shrubbery infested with scale.

In apple orchards we have to combat several serious diseases. Each disease producing parasite has its own life history and time of attack or time of dispersal. Thus, apple scab dispersal takes place primarily just with the formation and unfolding of the blossom clusters. To apply remedies after the blossoms drop is too late. Bitter-rot and blotch of the apple do not attack the fruit until about July 1st, or shortly thereafter. The spraying for apple scab should be timed

to prevent the scab parasite, but an entirely different timing applies to sprays to control apple bitter-rot and blotch and one or more others. The fire blight of pear and quince and the twig blight or blossom blight of the apple, all caused by the same bacterium, spread most easily and rapidly at blooming time, when the infection appears to be carried by bees, as well as by some other insects. It is very desirable to keep down infection at this time, so far as possible, if great labor is to be saved at a later time in cutting out and burning the blighted parts.

STRENGTH OF SPRAYS—CONFORMITY TO FORMULAE

Spray liquids are chemical mixtures having a definite strength, as stated in the formula for any given one. This strength of highest usefulness has been determined by experimentation, and calls for like care of weight and volume combination when the formula is reproduced. To this end orchardists are requested to follow the directions given, and to be certain that in each case a known composition of spray is used.

THOROUGHNESS OF APPLICATION

Without doubt many of the failures to get satisfactory results from spraying come from improper methods of application. The operator may suppose himself to be doing a very thorough job and yet from lack of knowledge be doing a very poor one. To control scale insects, it is essential that every bit of bark and every bud on the tree be entirely covered with spray so that none of the insects escape being hit, because only those that are reached by the spray can be killed. Likewise, it is necessary that both the upper and lower surfaces of the leaves be completely bathed with the spray shower in order to reach all insects harbored. When in doubt as to what spray to use, what combinations may be made or what precautions to observe when applying, write to the Experiment Station or to some other competent authority for information. Spraying improperly done is worse than no spraying at all, for it may be dangerous to the trees, or if not dangerous, the expense incurred and the time used will go for naught, and the operator is apt to conclude that spraying is of no value at all.

COMBINATIONS OF FUNGICIDES AND INSECTICIDES

The apple worm and the curculio do not deposit eggs to any extent for their first broods until after the petals drop from the blossoms. The arsenical poisons used to control the codling moth may properly be combined with those fungicides used to ward off later infections of apple scab and black-rot. In similar manner, the

occurrence of the second or July brood of the codling moth is practically co-incident with the danger period for bitter-rot, blotch and black-rot of the apple. Good business practice requires a combination of sprays at this time. Similar principles apply with respect to the sprays used upon peach, pear and plum, and the reasons which dictate the combinations are essentially the same.

THE SEASON'S PROGRAM

1. The season's program of spraying operations begins with spraying of fruit trees for San Jose scale where such spray is required by presence of scale. This application is best made as the leaf buds are swelling. Nearly all fruit trees, except possibly sour cherries, are likely to be infested with San Jose scale.

2. The next in order for the apple orchard and for the pear orchard is to apply the needed sprays to prevent infection by apple scab, and, if possible, by the blight bacterium. Some misapprehension exists concerning these sprays.* (See p. 56 at bottom.)

The experience of 1914 again confirms the need for applications of strong Bordeaux mixture on the opening clusters of both apple and pear, just before the blossoms open.

While the program herewith recommended is not put forth as a proved and perfect preventive of fire blight, scattered observations extending over several years, warrant us, we believe, in concluding that it will have an appreciable effect in reducing the extent of infection. This program is in no wise dangerous to follow, and it has been proved to be very valuable for a number of troubles other than blight, so that it ought to be very generally adopted, at least over all of southern Ohio, *regardless of blight*; and as our knowledge of the relation of insects to disease transmission grows, we are able to understand the probable explanation for its observed efficiency in curtailing the amount of blight. We now know that blight is transmitted by various insects such as plant lice, red bugs, the tarnished plant bug, bees at blossoming time, bark beetles burrowing into twigs and probably by many others which bite the leaves or buds, suck the sap from the twigs, make incisions into the bark to lay their eggs or creep into the crevices and wounds for feeding and shelter. A heavy spraying with lime-sulfur in which is found an excess of lime, approximates a whitewash which accumulates in the cavities and on rough places of the bark, thus discouraging the entrance of bark beetles, which Professor D. H. Jones, of the Ontario Agricultural College, has practically proved to be purveyors of blight; it also kills a considerable fraction of aphid eggs, as shown

by several investigators. The odor of the spray also repels some insects, thus reducing somewhat the number of possible carriers at blooming time. Bordeaux mixture, by its taste repels many biting insects, such as flea-beetles and leaf-beetles, and probably lessens, by considerable, the amount of scraping done by the Apple Flea-Weevil (*Orchestes canus*), the rose beetle and similar insects. Arsenate of lead, as a matter of course, kills such biting insects as partake of it in sufficient quantity. Spraying with nicotine sulfate solutions, or with kerosene emulsion, or miscible oils, to destroy aphids will assist in preventing dissemination of blight, and because of the relation of ants to aphids and their love for nectar, which induces them to visit the nectar glands of buds and leaves, as well as of flowers, and often to bite into such, we must regard them as most suspicious insects to be excluded, so far as possible, from the trees. Bands of tree tanglefoot over cloth or paper bands around their bases, or barrier tar on the ground out a short distance from the bases of the trees should exclude ants. Lime, well impregnated with crude carbolic acid and scattered over the ground in a circle about the bases of the trees, discourages visits by ants. The relation of insects to transmission of plant diseases is being given attention by the Departments of Entomology and Botany.

3. For application just after the blossoms drop from apple orchards, home-boiled lime-sulfur combined with arsenate of lead offers the best materials for the second and third sprayings. Upon pear, the lime-sulfur mixtures are very frequently injurious after the leaves come out, by reason of foliage injury. This is expressed in the subsequent outline of spraying operations, wherein detailed specifications are made for each treatment.

4. The first, second and third operations, just formulated, cover broadly the group known as Spring Applications; the summer diseases of new growth tissues and the second or later insect broods, as with the codling worm of apple, leave summer insurance as great a necessity as that already presented. These details are covered by two or more sprays of almost every orchard fruit to be made after July 1st. It may be remembered that the insurance protection which has been allowed to expire before the critical time, begets both financial loss and personal regret. Seek these details under Summer Applications, which are duly included and explained in the outlines given.

*From Bul. Cornell Univ. Exp. Sta. 335: 539-590, 1913, by Errett Wallace. * * * "There appears to be an opinion prevalent that winter spraying is important in connection with the control of apple scab. Several persons have advocated the substitution of the dormant spray for the application just before the blossoms open.

"The life history of the fungus in its relation to this point has already been discussed. Evidence presented in that discussion shows that the main source of early infection is the dead leaves. Spraying the trees before the leaves open cannot be expected to protect from this source of infection, because the leaves and young buds which are to be protected are not yet exposed so that the spray can reach them."

APPLE SPRAYING PROGRAM

For directions in making sprays, etc., see Spray Calendar, Bulletin No. 232. Read the notes at the end of program.

SPRING APPLICATIONS

Dormant Spray. For scale insects, lime-sulfur wash No. 14 (15-20-50 formula) or commercial concentrate, 6½ gals. to 50 gals. water; or miscible oil diluted according to manufacturer's directions, usually with 15 parts of water. Apply when buds are swelling.

Spray No. 1. (Pre-blossom spray). Stronger Bordeaux, 6-6-50 formula + 40 percent nicotine sulfate, 1 part in 700 of liquid (1 pint to 87½ gals.) Apply when blossoms show pink, just before opening. (For canker worms add arsenate of lead, 5 lbs. to 50 gals. of spray.)

Spray No. 2. (Calyx-cup spray). Lime-sulfur solution, home boiled (No. 14 or 15), or commercial concentrate, 1 part to 40 parts of water + arsenate of lead, 3 lbs. to 50 gals. of spray + nicotine sulfate, 1 part to 700 of spray. Apply just after the blossoms fall.

Spray No. 3. Lime-sulfur, home boiled as 2d, or commercial concentrate, 1 part to 40 parts of water + arsenate of lead, 3 lbs. to 50 gals. of spray. Apply 7 to 10 days after No. 2.

SUMMER APPLICATIONS

Spray No. 4. (Early July spray.) Bordeaux II (2-2-50 formula) + arsenate of lead, 3 lbs. to 50 gals. + nicotine. First week in July. Essential in southern Ohio where any blotch or bitter rot occurs. Often omitted in northern Ohio.

Spray No. 5. (Late July spray.) Bordeaux II (2-2-50 formula) + arsenate of lead, 3 lbs. to 50 gals. + nicotine. Apply two weeks after No. 4. At north, usually applied in late July or early August.

Notes: Dormant Spray. For best results use the home-boiled lime-sulfur wash containing an excess of lime, or a well made miscible oil, the former preferred. The home-boiled lime-sulfur contains an excess of lime and, therefore, approximates a whitewash in consistency. This wash will not only destroy scale insects but by crusting over and smoothing out roughnesses of the bark, entrance of bark beetles into the trunks and twigs is discouraged, and since these insects spread blight, the extension of the malady will be somewhat curtailed where bark beetles are abundant. Believed also to have value in destroying bacterial masses on blight cankers. The commercial concentrated solution is effective for scale but without the addition of considerable lime is of little or no protection against bark beetles.

Spray No. 1 is very essential for control of serious early scab infection, as well as that of cedar rust. We rely upon this spray for the checking of blossom infection by pear blight bacterium, as explained in the discussion on page 55. It also includes 40 percent nicotine sulfate, 1 part to 700 of liquid. This is to kill the newly hatched aphids which come just as the leaves are opening; the final status of this combination is not fully settled, and for the present some caution should be observed in its use. In the 6-6-50 and in other Bordeaux mixture formulae first grade stone-lime is meant—of hydrated or dry air slaked lime at least one-fourth more is required. See Bulletin No. 232. Nicotine sulfate of 40 percent strength is made by many insecticide manufacturers; early requests for stock supply of it will insure against delay in deliveries.

Spray No. 2 must be made in very liberal quantity for best results. Because of the control of codling worm and curculio by this spray, its omission is unthinkable for apple growing. Indeed, through a series of years Spray No. 2 ranks with the dormant spray and Spray No. 1 in its very great importance. The nicotine added is to finish the eradication of aphids and to catch the coming plant bugs and leaf hoppers. This spray tends to prevent secondary scab infection. A strength of arsenate of lead, less than 3 pounds to 50 gallons, even as low as 2 pounds to 50 gallons, has proved effective where very thorough spraying was done; on varieties like Ben Davis and Gano, which suffer from blossom end injury, reduction of arsenicals is suggested.

(Concluded on page 58)

PEAR SPRAYING PROGRAM

For directions in making sprays, etc., see Spray Calendar, Bulletin No. 232. Read the notes at the end of program.

SPRING APPLICATIONS

Dormant spray. For scale insects, same as dormant spray for apple, and same notes apply. It covers blister mite, *Psylla*, bark beetles and scale. Miscible oils are well adapted to pears.

Spray No. 1. (Pre-blossom spray). Stronger Bordeaux, 6-6-50 formula + 40 percent nicotine sulfate, 1 part in 700 of liquid (1 pint to 87½ gals.) (For canker worms add arsenate of lead, 5 lbs. to 50 gals. of spray.) Apply when leaves are half grown just before blossoms open.

Spray No. 2. (Calyx-cup spray). Bordeaux II (2-2-50 formula) + arsenate of lead, 3 lbs. to 50 gals. of spray + nicotine sulfate, 1 part to 700 of spray. Apply after blossoms drop.

Spray No. 3. Arsenate of lead, 3 lbs. to 50 gals. of water + nicotine sulfate, 1 part to 700 parts of spray. Apply 7 to 10 days later.

SUMMER APPLICATIONS

Spray No. 4. Ammoniacal Copper Carbonate (See Bul. 232), 2 to 3 weeks after No. 3.

Spray No. 5. Ammoniacal Copper Carbonate, 2 to 3 weeks after No. 4.

Notes: Spray No. 1 or Pre-blossom Spray is very essential to the checking of blossom infection by blight bacteria, as to destroy certain masses of them upon old blight cankers. By it, blight spread to apple may be kept down. It also controls pear scab in a large degree. Strong Bordeaux can be used without risk at this time. See notes under apple and discussion on page 55. Spray No. 2 is no less essential than Spray No. 1, since it controls the codling worm when thoroughly made. Strong Bordeaux mixture at this time in danger of russetting fruit; slight russetting may occur at times from Bordeaux II, though risk appears less than from lime-sulfur, which is too apt to injure foliage of pear.

Sprays No. 4 or 5 or summer applications are required to prevent sooty fungus and leaf-spot. No arsenicals seem to be needed on the pear for second brood codling worm, but sometimes are advised for the second brood of pear slugs.

(Apple notes concluded)

Spray No. 3 is the one that is most often omitted by the small orchardist. If any omissions must be made, this is the safest one of all the numbers to omit, especially when preceding applications were thoroughly made.

Sprays No. 4 and No. 5 are both required to control bitter-rot, blotch, late summer black-rot and the foliage development of cedar rust and scab, as well as the second brood of codling worm, in southern Ohio. Lime-sulfur has too often failed as a fungicide in districts where apple rots and blotch occur. Either Bordeaux II or lime-sulfur controls sooty and fly-speck fungus. In northern Ohio but one summer spray is sometimes made in late July or early August, since the problem is largely one of control of second brood codling worm.

PLUM SPRAYING PROGRAM

For directions in making sprays, etc., see Spray Calendar, Bulletin No. 232. Read the notes at the end of program.

FOR EUROPEAN VARIETIES

SPRING APPLICATIONS

Dormant Spray. For scale insects, dormant strength lime-sulfur. In early spring.

Spray No. 1. Bordeaux I (4-4-50 formula) + arsenate of lead, 3 lbs. to 50 gals. Apply when buds are swelling.

Spray No. 2. Bordeaux I (4-4-50) + arsenate of lead, 3 lbs. to 50 gals. Just after calyx drops.

Spray No. 3. Bordeaux I (4-4-50 formula) + arsenate of lead, 3 lbs. to 50 gals. Apply 2 weeks after No. 2.

SUMMER APPLICATIONS

Spray No. 4. Bordeaux I (4-4-50 formula). 3 weeks after No. 3.

Spray No. 5. Ammoniacal Copper Carbonate. As fruit begins to color. On late varieties repeat Bordeaux I.

Notes: Sprays Nos. 1, 2, and 3 include early season treatments to control rot, curculio, and shot-hole fungus. Nicotine sulfate (40%) 1 part to 700 of liquid may be added if aphids are threatening.

Sprays Nos. 4, 5 and possibly 6 are continued to control the brown-rot and the shot-hole fungus. These summer sprays keep down black-knot infection.

In all rot spraying the treatment has little value unless old mummy plums are removed and destroyed at the beginning of the season.

FOR AMERICAN AND JAPANESE VARIETIES

SPRING APPLICATIONS

Dormant Spray. For scale insects, dormant strength lime-sulfur. In early spring.

Spray No. 1. Bordeaux I (4-4-50 formula) or self-boiled lime-sulfur (10-10-50 formula) + arsenate of lead, 3 lbs. to 50 gals. Apply when buds are swelling.

Spray No. 2. Self-boiled lime-sulfur (10-10-50 formula) + arsenate of lead, 3 lbs. to 50 gals. Just after calyx drops. Bordeaux or commercial lime-sulfur injures foliage.

Spray No. 3. Self-boiled lime-sulfur (10-10-50 formula) + arsenate of lead, 3 lbs. to 50 gals. 2 weeks after No. 2.

SUMMER APPLICATIONS

Spray No. 4. Self-boiled lime-sulfur (10-10-50 formula) when required by appearance of rot.

Spray No. 5. Repeat Spray No. 4, 10 to 15 days later.

Notes: Add nicotine sulfate (40%) 1 part in 700 of liquid to sprays 1, 2 and 3 if aphids are threatening.

PEACH SPRAYING PROGRAM

For directions in making sprays, etc., see Spray Calendar, Bulletin No. 232. Read the notes at the end of program.

SPRING APPLICATIONS

Dormant Spray. Dormant strength lime-sulfur as buds are swelling.

Spray No. 1. Arsenate of lead, 3 lbs. to 50 gals. About 10 days after the petals fall or when bloom husks are shedding from the young fruit.

Spray No. 2. Self-boiled lime-sulfur + arsenate of lead, 3 lbs. to 50 gals. Apply 10 days after No. 1.

SUMMER APPLICATIONS

Spray No. 3. Self-boiled lime-sulfur (10-10-50 formula). 3 or 4 weeks after second spraying.

Spray No. 4. Self-boiled lime-sulfur (10-10-50 formula). 2 or 3 weeks after third spraying.

Spray No. 5. Repeat No. 4 on later varieties subject to scab.

Notes: Dormant Spray of the peach controls both scale and leaf-curl in one application.

Sprays No. 1 and No. 2 are to control curculio in a safe fungicide as to No. 1, since Bordeaux mixture causes severe injury to peach foliage. Add nicotine sulfate (40%), 1 part to 700 parts of water if aphids are threatening.

Sprays No. 3 and No. 4 are required where brown-rot and scab of fruit are present. With late late varieties like Salway, Heath Cling, etc., which suffer from scab, a third or No. 5 Spray will commonly be needed.